Teaching Resources for Dermatology on the WWW - Quiz System and Dynamic Lecture Scripts using a HTTP-Database Demon

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The World Wide Web (WWW) is becoming the major way of acquiring information in all scientific disciplines as well as in business. It is very well suitable for fast distribution and exchange of up to date teaching resources. However, to date most teaching applications on the Web do not use its full power by integrating interactive components. We have set up a computer based training (CBT) framework for Dermatology, which consists of dynamic lecture scripts, case reports, an atlas and a quiz system. All these components heavily rely on an underlying image database that permits the creation of dynamic documents. We used a demon process that keeps the database open and can be accessed using HTTP to achieve better performance and avoid the overhead involved by starting CGI-processes. The result of our evaluation was very encouraging.

INTRODUCTION

Lecture scripts and collections of frequently asked questions of the past examinations are very popular among students. Dermatology, however, relies on clinical and histological images of diseases. Using conventional media, color images are much too expensive to be used. This was one of the main reasons why we decided to use computer based training and teaching (CBT) to support our students. It turned out that the resources created are also useful for continuing medical education and reference. Another problem with conventional media is the lack of interaction and specific feedback. However, to date most teaching applications on the World Wide Web (WWW) do not use its full power by integrating both interactive and dynamic components.

We have set up a CBT-framework for Dermatology that consists of dynamic lecture scripts, case reports, an atlas and a quiz system (fig. 1). All these compo-nents heavily rely on an underlying image database and are offered to the students or teachers through the WWW. The database allows easy maintenance, flexible data representation, and fast querying.

METHODS

As WWW-server we used a Sparc 20 workstation running Solaris and the Netscape Commerce Server. All programs except the database (DB) demon (=daemon; "Disk And Execution MONitor") were performed using the common gateway interface (CGI) of the WWW-server and were written in the Practical Extraction and Report Language (PERL).

For educational purposes we have picked about 2,000 slides from our archive consisting of roughly 100,000 slides. This selection covers all important diagnoses and uses the most characteristic images of the highest photographic quality. These images were scanned commercially and stored on Kodak Photo CD. Images with a resolution of 768 x 512 x 24 were enhanced in Photoshop or Photostyler and JPEG-compressed with a quality factor of 60 (= 1:37) with the Ulead-implementation available in Photostyler 1.1a. Information on the images was stored and maintained in an Access database that is only used locally.
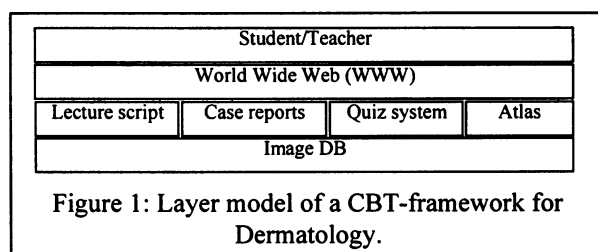
Documents were authored utilizing HTML Assistant, Microsoft Internet Assistant, simple text editors, and Visual Basic. We used HTML 2.0 and a few extensions proposed for HTML 3.0, like tables. As a frontend, we used Netscape Navigator and NCSA Mosaic.

DB demon

The INFORMIX database that is offered in the Internet holds a subset of the data of the local Access database. We set up a demon process that opens the INFORMIX database and then waits for queries on specified ports. It was written in C using Embedded Structured Query Language (ESQL). The corresponding client may be a CGI-program or a WWW-browser, because the demon understands both a proprietary protocol and the Hypertext Transfer Protocol (HTTP).

Dermatology atlas

Using the database and key systems[2] three different methods to access the images of the Dermatology

Student/Teacher			
World Wide Web (WWW)			
Lecture script	Case reports	Quiz system	Atlas
Image DB			

Figure 1: Layer model of a CBT-framework for Dermatology.

Online Atlas (DOIA) are offered: a) query interface, b) static access structure, c) HARVEST.

The query interface was implemented with a slightly modified Generic Structured Query Language[1] (GSQL) that provides the WWW-user interface and the mapping to SQL. A table based query form is offered where the user can define restrictions and configure how results should be displayed.

A static access structure interconnected by hyperlinks based on the diagnosis (alphabet, ICD) was generated from the local database using Visual Basic scripts.

Further, full text retrieval was supported using HARVEST[3] (with GLIMPSE as search subsystem) on the basis of the static access structure and additional META-tags, which were included for structured querying.

Dynamic lecture scripts and case reports

For our students, we have developed lecture scripts which summarize the most important facts given in the lecture. They contain text and all slides shown in the lecture. In a similar way physicians report about rare and interesting diseases and effects of therapy in so called "case reports".

In the lecture scripts sometimes one static link to an illustrative image and another link to all related images was included as a database query. Such a query could be »select * from image where diagnosis_text like '%eczema%' and age < 4« for all eczema in infants. This query could be coded like »<a href= "http://db.demon:8081?diagnosis_text+like+'%eczema%'+AND+age+<4">click for more images«.

Quiz system

The Quizsystem was implemented using PERL, PERL "databases" that can store associative arrays, and text files (due to the limitation in the length of records in PERL). For the explanation of the quiz
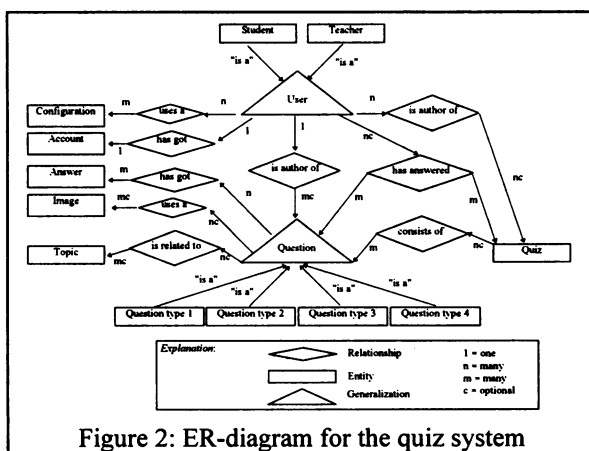
system an Entity-Relationship (ER) diagram[4] is used showing the data structures (fig. 2).

Two kinds of users exist, students who use a quiz, and teachers who ask questions and construct a quiz. A user may be a student and a teacher at the same time. Every user has to have one account which specifies his rights and a password. For every user and network address a configuration exists which contains color correction information for computer and monitor. A user may be author of none, one, or multiple questions, but there is one and only one author responsible for a question, whereas a quiz may have multiple authors. A quiz consists of at least one question. For each student his previous answers on questions in a given quiz are stored. Questions may be related to none, one, or more topics. The topics help with the selection of questions when constructing a quiz. Each question may use none, one, or more images and images may be used in no, one, or more questions. For all questions at least two answers and accompanying explanations exist. In addition a general explanation for the question is given. In a written examination of our students there are four different kinds of questions all using single-choice answers.

The quiz system can be used and maintained completely with a Web browser[5]. Three different modes of presentation may be chosen for a quiz: a) single question, b) all questions, c) random.

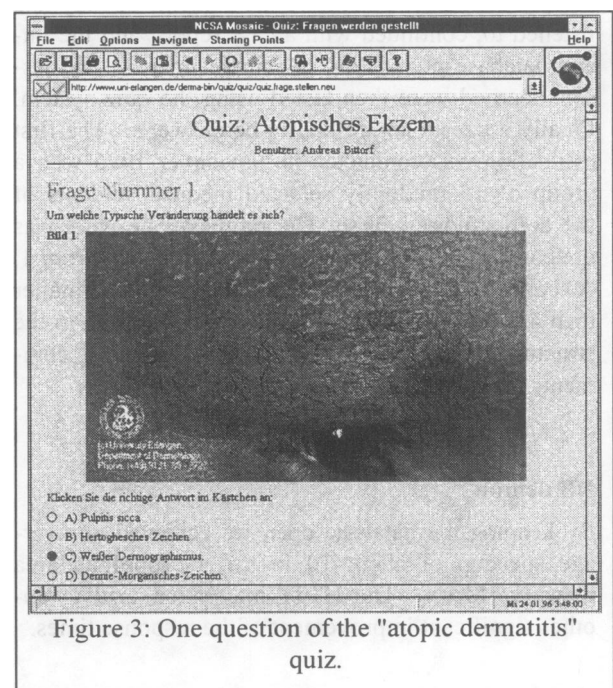Answers are given by selecting a radio button (fig. 3).

Figure 3: One question of the "atopic dermatitis" quiz.

Figure 2: ER-diagram for the quiz system

The answers of the user are evaluated and scored. A general explanation to the question is given provided that the answer was right. Additionally, specific explanations are given for wrong answers. Right and wrong answers are recorded. The next time the student starts a quiz he has already been working on, he has to answer all questions that he did not yet answer right. Once a quiz is completed the student may reset his prior score and try the quiz again.

Maintenance of the quiz database is possible using a Web-browser. First, questions have to be entered to the database. A specific input interface was designed for each of our four types of questions. The presentation is flexible so that any number of alternatives and images may be used in each question. Usually one or more topics will be selected which are suitable for the question. In the next step, a quiz has to be selected or created. All questions meeting previous specified constraints (author, topic) are displayed in a short form, hyperlinked to the full text. A checkbox in front of the question shows whether it is already included in the quiz or not. A quiz can be rapidly designed by selecting the according checkboxes. Of course, questions may be used in multiple quizzes.

Evaluation

The whole CBT-system has been used by medical students as part of a course. The exercise was done in groups of two using a guided tour. Two tutors gave a short introduction and helped with problems. The one hour course started with a short lecture script on "atopic dermatitis", a lecture the students already had listened to, continued with a case report, and the image database giving lots of sample images. The lessons learned were then tested using the quiz system. Finally a questionnaire had to be answered. The first evaluation was conducted in November 1995 with a group of 15 randomly selected medical students of the dermatology course. The rating of the parts was done using the German school marks ranging from 1, "excellent" to 6, "insufficient", where marks smaller than 4.5 are equivalent to "passed". In addition to the structured questions the students could give comments.

RESULTS

DB demon

By keeping the database open we achieved an average speedup of about 10 in the metropolitan area network (MAN). The HTTP-integration lead to another significant improvement of the response times.

Dermatology atlas

Response times of the database query interface are very short, within our MAN. Without thumbnails about 30 hits per second, with thumbnails one hit per second are displayed on average. In contrast, HARVEST queries took 5s and more.

Evaluation

The results of the first evaluation are shown in table 1. For rankings mean values ($\emptyset$) and median (m) are given. The comments of the students included requests for "better structure (case reports)", and "faster access times, i.e. for the quiz system". The importance of the images was stressed. Overall, there was a good response to the exercise.

Table 1: Evaluation of our CBT-system (n=15)
($\emptyset$ = mean values; m = median)

Question	Answers	
Computer experience?	Yes	67%
	Little	22%
	No	11%
Computer ($\geq$ 65K colors, $\geq$ 486er)?	Yes	67%
	No	33%
- Modem?	Yes	0%
	No	100%
- CD-ROM?	Yes	100%
	No	0%
Attitude towards CBT?	Positive	44%
	Do not know	56%
	Negative	0%
Prior WWW experience?	Never heard	33%
	Heard	22%
	Seen	22%
	Used	22%
	Regular user	0%
	Author	0%
CBT elements?	Lecture scripts	$\emptyset$ 2.56; m: 2
	Case reports	$\emptyset$ 2.22; m: 2
	Atlas	$\emptyset$ 1.56; m: 1
	Quiz	$\emptyset$ 2.11; m: 2
Image quality?		$\emptyset$ 1.67; m: 2
Would like to use this CBT system for preparation?	Yes	56%
	Undecided	33%
	No	11%
Buy this as a CD-ROM?	Yes	78%
	No	22%
Acceptable cost?	(US $)	$\emptyset$: 45, m: 41

To date the WWW-server containing the dermatology resources is reachable without restrictions. The access

numbers have drastically increased during the last one and a half year. In March 1996, we received over 7500 hits per day. DOIA got by far the most hits, followed by the case reports and lecture scripts. The quiz system was accessed 150 times in February.

DISCUSSION

HTTP DB demon

Direct HTTP-integration of a database demon improved the performance significantly, because the time consuming task of forking processes (CGI) on a heavily loaded Web-server and additional TCP/IP communication can be saved. The effect of keeping the database open has been previously reported in accordance with our results[6].

Dermatology atlas

A complex structure like DOIA cannot be maintained without using a database. It has proven to be useful to offer a hierarchical access structure to our images using the diagnosis, because no CGI-programs are necessary, and server load is reduced. Further, all data can be indexed by any search engine and used for distribution mechanisms like HARVEST. It allows the novice user to get an impression of what kinds of images are available and how to ask queries just by following hyperlinks. Implicit or explicit relationships from the database can be mapped to links thus offering meaningful means for navigation.

Both implementations for querying in DOIA, the database integration and the HARVEST based search mechanism, have advantages. The database interface is very fast and supports structured querying. Further, the display of the result can be configured in a very flexible way and server load is moderate. HARVEST is not as fast and the situation gets worse with the number of records to be queried. On the other hand it offers functionality for text retrieval and is a single and flexible query interface to heterogeneous distributed data[7].

Dynamic lecture scripts and case reports

A lot of universities have started to set up teaching material for their students. However, we have used dynamic scripts which link to an underlying database. In our application this is very helpful, because the complete collection of images available in the database can be shown upon mouse click. Thus, a nice side effect of adding images to the atlas is that the scripts may become more complete. The images are so important because diagnostic skill is developed mainly by seeing many characteristic images of a disease.

By following the links provided with the images, a student may find interesting case reports. Usually case reports are used for the continuing medical education, however, interested students may use this resource as well, for example, to view exceptional images.

Quiz system

The great advantage of the PERL solution compared to a relational database is the easy portability as PERL is available on nearly every Web-server. However, the PERL solution has some drawbacks. Database integrity control is absent, there are no mechanisms for recovery, the data structures can not be changed easily, and there are no mechanisms provided to deal with big collections of questions, that is the performance decreases proportional to the number of questions.

Our quiz system can be maintained with a Web browser without writing any line of Hypertext Markup Language (HTML). We consider this to be important because we do not agree with the statement that due to the simplicity of HTML, teachers do not need any special skills[9]. This may be true in a technical environment, but it is definitely not valid for physicians.

Our situation is different to this of CyberProf[10], where a sophisticated grading package has been implemented. We just use a simple scoring mechanism where a score is given for each answer depending on its value. It is also different with respect to the feedback, because we can easily provide specific feedback due to the limited answer possibilities. Using single choice questions from the examinations turned out to be a good idea as no text input was necessary. Acceptance would have been less if keyboard input would have been required.

CyberProf has the capability of creating different questions for every user, for example by using other numbers for computation. We also could implement a dynamic assignment of images to questions using the database interface and a random function. However, we did not implement it yet, as we like to have control over what is presented to the student at least in single and all questions modes. Dynamic assignment of images may be an interesting extension for the random question mode.

The single question mode is comparable to an oral examination. This mode is recommended only if a fast network connection is available to avoid dissatisfaction by long transfer times. Comparable to a written examination is the all questions mode, where the

student can select the questions he wants to answer first and no direct feedback is provided before the end of the examination. We also recommend this mode with a slow connection as a student may do other work, for example in a text processor, while the whole quiz is downloaded. The random mode is intended for a fast repetition of the lecture few days before the examination. By keeping track of the questions answered right and wrong, difficult questions may be asked again.

Within the WWW it turned out that an artificial user name is not acceptable. It is hard to remember the user id the next time. Due to this we decided to use given name and last name together with a password.

Evaluation

Previous work has concentrated on aspects like creating a structured view of teaching resources[9], however, we have only set up a homepage that contained a guided tour. A part of the students had hardly any computer experience, but they got along quite well with a little help by the tutors. A conclusion is that the WWW is a suitable starting point to get used to a computer.

We were very surprised by the result of the questionnaire. The computer equipment of the students was very good and all students with suitable equipment were interested in purchasing a CD containing the CBT-material, despite the fact that half of the students selected "do not know" when asked whether they like CBT or not. Also the rating of the components was very good considering that only two students had ever used the WWW before. None of the students had a modem at home, thus in the future mechanisms for interaction should be provided to work without WWW-server, e.g. using JAVA.

The acceptance of our WWW-server is surprisingly high. The image atlas part is by far the most popular, which shows the importance of images for education and reference.

CONCLUSION

A CBT-framework based on an image database was implemented for dermatology. For the user, only a WWW browser is required. The results of the pilot course we conducted in this term were very encouraging. In the next term the resources will be tightly integrated in the student education.

Acknowledgments

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